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Science and Technology in China's Modernization

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Volume II: Annexes

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NIE 13-7/2-86/II

SCIENCE AND TECHNOLOGY IN CHINA'S MODERNIZATION

VOLUME II: ANNEXES

Information available as of 25 June 1986 was used in the preparation of this Estimate, which was approved by the National Foreign Intelligence Board on that date.

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PREFACE

This Estimate is published in two volumes. Volume I is the Key Judgments and Discussion. Volume II contains the supporting annexes. (U)

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ANNEX A

Priority Technologies

Microelectronics

1. Microelectronics is a top priority in China's S&T modernization because it is the basis for producing computers, telecommunications equipment, and other electronic products that are vital to China's industrial and military modernization. China's investment in microelectronics production technologies in the last five years has been significant. However, China's microelectronics industry will be built almost entirely on foreign technology. Because of this dependency, the pace of development in China's microelectronics industry will be determined in large part by the ability to acquire and assimilate the necessary fabrication equipment. [redacted]

2. Currently the microelectronics industry in China can produce some 16k DRAM (dynamic random access memory) devices. This capability reflects production lines capable of processing integrated circuit (IC) designs down to the 5 micron level. China's current production is based largely on two- and three-inch wafers, although the yields are relatively low. Within the next few years China may begin producing some 64k DRAM and 16k SRAM (static random access memory) devices. By the mid-1990s, a few of the better semiconductor production facilities may process four-inch wafers and be capable of producing ICs with design rules at the 2 to 3 micron level. [redacted]

3. Microelectronics production equipment is expensive and difficult to install and operate, so progress is likely to be slow. Even after the new equipment is delivered, several years often are required before a microelectronics facility in China reaches full production potential. Shortages of skilled personnel, reliable power sources, and inadequate quality control are among the major impediments to progress. Additionally, current domestic production focuses on simple circuits for consumer products, to the detriment of developing capabilities to produce more advanced ICs. Moreover, factories will be reluctant to fund purchases of new equipment frequently enough to adopt the newest technologies. [redacted]

4. The Leading Group for the Invigoration of the Electronics Industry is working to establish several major centers for the development of semiconductors and computers, but progress has been slow—in part due to funding problems and bureaucratic rivalry among the cities wishing to host the centers. In the meantime, several CAS facilities including the Institute of Electronics, the Institute for Semiconductors, the Institute of Electrical Engineering, and the Ministry of Electronics Industry (MEI) carry out electronics research. The MEI, with 2,400 enterprises, also manages the development and production of electronics products for both civilian and military needs. However, most of the new microelectronics technology introduced in China within the next 10 years probably will come from foreign sources. [redacted]

Computers and Software

5. By the 1990s China's modernization programs will begin to realize important benefits from the strong emphasis on developing computer capabilities. Deng Xiaoping, Premier Zhao Ziyang, Party Chairman Hu Yaobang, and other senior officals have specifically endorsed the production and use of computers in China. Also, Chinese access to technical literature has played a key role in developing computers in China. Even at this early stage, progress has been impressive. In 1983 the Chinese unveiled the Galaxy supercomputer, which—though it reflects mid-1970s technology and may operate at only 25 percent of capacity—is an achievement that continues to elude the Soviet Union. [redacted]

6. Much of China's success is due to access to foreign technology. China has been able to buy a wide variety of Western computers, and over a hundred foreign firms have been involved in negotiations to set up computer production lines in China. These lines contributed in particular to China's production of microcomputers, which are three to five years behind the West. Also, access to technical literature has played a key role in developing computers in China. For example, knowledge of parallel architecture from such publications probably was critical in producing the Galaxy. In addition, large numbers of Chinese

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students have enjoyed access to the best schools and research facilities in the West. We estimate that roughly two-thirds of China's computer inventory is imported. Most of the domestically produced computers—more than 30,000 last year—rely heavily on imported parts. China's growing computer industry already numbers over 90,000 employees in several dozen research facilities, 111 manufacturing plants, and 40 service organizations. [redacted]

7. However, the industry has been characterized by little attention to standardization, long delays in establishing production lines, and relatively low levels of productivity once they are operational. For example, a microcomputer production line imported from France in 1979 did not go into production until 1983. By the time computer lines become operational, they often are obsolete. China has yet to make the transition in mass production from 8-bit to 16-bit microcomputers. Chinese computers also tend to be more expensive and less reliable than similar models available in the West. In addition to problems in domestic production, computer imports were drastically curtailed in 1985 after several years of sharply rising purchases, in part to protect the emerging domestic industry and to conserve hard currency reserves. [redacted]

8. The use of computers also is growing rather slowly. About 70,000 computers are sitting in warehouses, and as many as 80 percent of the approximately 200,000 computers in China are not being used effectively. The lack of trained personnel, software, peripheral equipment, and supplies contribute to this poor utilization of computers. [redacted]

9. Chinese software may develop somewhat faster than hardware because it involves primarily mental labor rather than the sophisticated equipment necessary for hardware production. One major software application is Chinese character representation and translation. Two major centers for software development are being established, each with about 1,000 programers, as part of a Chinese objective to increase the number of software specialists from about 10,000 now to about 100,000 by 1990. [redacted]

10. While Chinese computers probably will not be a major factor on the world market in the next decade, China may narrow significantly the gap with the Soviet Union in computer technologies in the 1990s, if present trends continue (see table A-1). These trends include encouragement of the proliferation of computers by the top political leadership, access to foreign technology, and thousands of students studying computer science abroad. [redacted]

Table A-1
Computers in China and the USSR, 1985 [a]

Number of units (except where noted)

	China	USSR
Stocks	200,000	66,000
Microcomputers	190,000	6,000
Minicomputers/mainframes	10,000	60,000
Domestic output	32,000	5,000 to 7,500
Microcomputers	30,000	1,000
Minicomputers/mainframes	2,000	4,000 to 6,500
Imports		
Units	65,000	4,000 to 5,000
Value *(million US $)*	328	NA

[a] Estimated. Reliable statistics on the Soviet and Chinese computer sectors are scarce. Our estimates are drawn from Chinese and Soviet statements and analysis of trade data.

This table is Confidential [redacted]

11. China's relatively slow progress in the production and use of computers should not lead to complacency on our part, however. Substantial resources and talented people are, no doubt, working on projects that we are not aware of and could achieve major breakthroughs. The Galaxy supercomputer is an example of the type of a successful project the Chinese were able to keep secret, despite the involvement of over 20 facilities working over a five-year period and the use of many foreign components, probably including about 200,000 integrated circuits from the United States. [redacted]

12. Research on computers and software is conducted at over 100 facilities operated by the CAS, universities, factories, and R&D facilities of the Bureau of Computer Industry (BCI) of the Ministry of Electronics Industry. Among the leading R&D facilities are the Institute of Computer Technology, the National Defense S&T University at Changsha that worked on the Galaxy supercomputer, and the Beijing Research Institute of Electronic Applications. Despite the expansion in computer and software R&D facilities, China will continue to depend heavily on foreign technology for major advances over the next decade. [redacted]

Telecommunications

13. Telecommunications research is conducted primarily by the Ministry of Posts and Telecommunications (MPT), the MEI, and CAS. Among the important subordinate research facilities are the Fourth Radio

Research Institute in Xian, the Beijing Communications Research Institute, the Shanghai Microwave Research Institute, Xian Electromechanical Laboratory, and the Communications, Telemetry, and Telecontrol Research Institute in Hebei. Satellite R&D is conducted largely by the Chinese Academy of Space Technology, subordinate to the Ministry of Astronautics Industry. The military is a driving force behind both fiber optics and communications satellite programs.

14. Modernization efforts in this high-priority area are focused on acquiring the manufacturing technologies needed for production of modern communications systems, including high-capacity digital transmission and switching equipment, satellite components, fiber optics, and military command and control systems. Domestic production capabilities have lagged well behind rapidly increasing demands. China produces mostly analog equipment, for example, but plans to convert to digital systems for high-speed data transmission and secure telecommunications. China's indigenous research and development in telecommunications are hampered by poor quality and limited availability of components, inadequate technical knowledge, lack of test equipment, and manual production lines. In the past several years, China has purchased advanced systems and some production technology that will considerably improve telecommunications services offered, although it will continue to be dependent on foreign technology.

15. Domestic production capabilities for telephone switching gear are largely limited to electromechanical systems based on 1960s technology and some electronic controls. The Chinese press announced the first domestically produced microprocessor-controlled switch in mid-1985, but no further information on this claim is available. A Chinese joint venture with a Belgian subsidiary of a US firm began operations in late 1985, and has the potential for significantly enhancing Chinese switching capabilities.

16. China has made progress in developing communications satellites, but some problems have emerged. China has launched two communications satellites, a significant accomplishment, but they have limited capabilities and are experiencing operational difficulties. We believe the satellites include some foreign components despite Chinese claims of being domestically produced. China also has given conflicting signals on procurement of foreign satellites. Beijing recently indicated that plans to purchase foreign satellites, including a direct broadcast satellite, have been canceled. But we believe that the many problems facing Chinese communications satellites will eventually lead Beijing to reenter the international market and possibly purchase or lease transponders, or buy an entire satellite, perhaps even one already in orbit.

17. Progress also has been slow in developing a direct broadcast communications system. Negotiations on the purchase of direct broadcast satellites have been drawn out over several years, in part because of an inability to decide which type of system should be used (Ku, C, or S band), differing views on the preferred source, or the need for foreign procurement.

18. The Chinese have made progress in their research on fiber optics, although they are experiencing problems in key areas such as single-mode optical fibers, transmission devices, and large-scale production. China has several dozen short fiber optic lines in operation. According to Chinese press reports, most are 8.5 megabits per second, although they do claim some are 34 megabits per second systems. China has signed agreements with several foreign suppliers for the purchase of high-speed 140 megabits per second fiber optic transmission systems for both intercity and intracity use. The sale to China of technology for fiber optics and fiber optic transmission systems requires COCOM approval, which slows the acquisition process. Nevertheless, China has purchased, with COCOM approval, the technology, equipment, and training to produce fiber optic cable and some components. By the late 1990s, fiber optic systems probably will link Beijing, Shanghai, Shenyang, Nanjing, Wuhan, Guangzhou, and a few other major cities.

Automated Manufacturing

19. China is in the very early stages of developing automated manufacturing capabilities. In 1985 there were only about 100 robots in China, located mostly in research facilities, such as the Shenyang Institute of Automation (SIA), Qinghua University, Chengdu University of Science and Technology, and Jiaotong University. The Ministry of Machine Building Industry also conducts robotics R&D. A national center for robotics is to be established at SIA by 1989, but to date most of the robots have been imported and the 10 or so that have been assembled in China involve largely foreign components. They represent first-generation robotics for the most part, capable of point-to-point transfer operations. Work is just beginning on second-generation robotics that involve continuous computer control of spatial motion for light assembly and processing. Some computer-numerical-controlled machines are being produced, while considerable Western computer-aided design, manufacturing, and

testing (CAD, CAM, CAT, respectively), technology is being imported. Joint ventures in these areas are being sought and some research on robotics is beginning.

20. The gap in automated manufacturing capabilities between China and the West is likely to persist. China will have to master microelectronics and computer technologies before substantial advances in robotics are likely. Despite the many Chinese students abroad studying key subfields, such as software development and programming, assimilation of new technologies probably will be slow.

Transportation

21. Indigenous research on transportation systems is weak. Much of it is conducted by research components of factories under the various ministries. The resulting Chinese designs for vehicles, aircraft, and ships draw heavily on foreign models. This situation is unlikely to change in the foreseeable future. Thus the vast majority of technological improvements in the transportation sector over the next decade will be the result of technology transferred from abroad. In particular, joint ventures and licensing arrangements will be critical to upgrading both the methods of production and the vehicles produced.

Energy

22. Energy research and development is conducted by facilities under the CAS, the Ministry of Coal Industry, the Ministry of Petroleum Industry, the Ministry of Water Resources and Electric Power, the Ministry of Nuclear Industry, the Ministry of Machine Building Industries, plus several universities. The Institute of Atomic Energy in Beijing, the Institute of Energy Resources, and the Shanghai Institute of Nuclear Research are among the key CAS energy research organizations. This broad research base, combined with active programs to acquire foreign technology, should improve the overall energy picture in China. Nevertheless, the demand for energy is outstripping China's ability to increase production.

23. China's severe shortage of electric power will continue to limit the pace of economic expansion and modernization for at least another decade. Existing shortages that result in many factories operating well below capacity are compounded by the rapidly increasing demand for power that exceeds China's ability to expand power production. Efforts to reduce this gap involve a wide variety of technologies necessary to more efficiently convert China's abundant natural resources into a reliable, widespread supply of energy.

Table A-2
China: Energy Production

Million tons of coal equivalent [a]

	1980	1985	1990 [b]
Total	637	840	998
Coal	442	606	714
Oil	152	179 [c]	214
Hydroelectric	24	38	50
Gas	19	17	20
Nuclear	0	0	NEGL

[a] According to official Chinese conversion factors, 1 metric ton of coal equivalent energy is defined as the amount of fuel required to provide 7 million kilocalories of heat energy. This is equivalent to 1.4 metric tons of raw coal, 0.7 metric ton of crude oil, 752 cubic meters of natural gas, and 2,421 kilowatt-hours of electricity.
[b] Estimated.
[c] About 20 percent of the oil production was exported.

This table is Unclassified.

Most of these technologies are readily available from abroad, but the Chinese preference to produce equipment, rather than buy end items, has delayed modernization of the energy sector.

24. Coal will continue to account for over 70 percent of China's primary energy (see table A-2). Production increased to 850 million metric tons of raw coal in 1985, surpassing the coal output of the Soviet Union. About half of the production is from the more modern large-scale mines, which are only about one-third mechanized. The other half is provided by small mines that usually lack modern equipment. To meet increasing demands, the coal-mining process will need to be increasingly mechanized. But, progress has been slow in establishing manufacturing lines to produce modern mining equipment. In addition to the shortage of mining equipment, transportation is a serious obstacle. China's railroads cannot currently move the coal as fast as it can be mined.

25. Oil exports are essential to modernization because they provide more than 20 percent of China's foreign exchange. But offshore exploration has been disappointing, and onshore exploration has only recently increased. However, foreign technology has improved both production and exploration. More surveying technology is being incorporated, along with computers to process the large volume of seismic data collected. As exploration shifts to more difficult locations, advanced technology will be increasingly in demand. To help attract this technology, China is now

willing to allow foreign involvement in onshore exploration. China is also upgrading drill bit manufacturing and other important technologies. At the same time, Chinese crews are becoming more proficient at using modern drilling methods. To keep pace with expected improvements in drilling, China's refining capacity is to increase by 30 percent over the next five years, according to plans. Much of this expansion will incorporate foreign technology. However, the declining price of oil may cause Beijing to scale back some of these plans. In a related development, China plans to convert oil-burning electrical power plants to coal. This will allow additional heavy fuel oil to be further refined to more valuable, lighter products, such as gasoline. [redacted]

26. Hydroelectric power has tremendous potential in China, although the main sources are located in the southwest, a great distance from power-short areas. One major emphasis in hydroelectric power has been on establishing a large number of smaller generating plants to supply primarily rural users. Overall, hydroelectric power output has grown at over 10 percent over the last five years. Further increases in hydroelectric power probably will involve substantial imports of foreign technology, including generators and automated production lines for large generators. [redacted]

27. Plans to develop nuclear power to supplement existing energy sources have been delayed. Although China is attracted by several features of nuclear power including the ability to locate plants near the industries requiring the power, the high cost of developing nuclear power has limited the scale and progress of development. Completion of China's first nuclear power plant has been postponed several times and now is delayed to 1990. This 300-megawatt (MW) reactor will rely heavily on foreign parts and technology. Plans also call for about six more reactors in the 600- to 1,200-MW range to begin construction in the next few years, but two of these are likely to be shelved indefinitely. Even if all these plants come on line, they will contribute less than 5 percent of China's power by the end of the century. China's plans to produce small, 150- to 300-MW reactors for sale to Third World countries are also unlikely to materialize in the next five to 10 years. [redacted]

Special Structural Materials

28. Research on special structural materials is conducted under the auspices of the CAS, several ministries, including the Ministry of Aeronautics Industry, and universities. Among the more important CAS research facilities in this field are the Beijing Institute of Chemistry, the Shanghai Institute of Metallurgy, the Beijing Institute of Chemical Metallurgy, the Shanghai Silicate Institute, and the Shenyang Institute of Metals. Chinese research in metallurgy, ceramics, and composite materials appears to be quite good based on published research and papers presented at international conferences. Translating the research into production, however, remains a major problem. [redacted]

29. Military applications of advanced composite materials—including reentry vehicles and rocket motor casings for ballistic missiles—have been an important motivation behind China's intensive efforts to establish capabilities to produce carbon-carbon and other advanced materials. Considerable progress along these lines has been achieved in laboratory research, but the manufacturing technology for volume production has not yet been mastered. [redacted]

30. Several of China's efforts to acquire advanced materials technology have paid off. For example, Kevlar-type high-tensile-strength aramid fibers were produced in a CAS laboratory in 1979, and limited production was undertaken in 1982. Also, the most significant progress has been made in carbon-carbon materials. Three-dimensional carbon-carbon material currently produced in China is identical to that used in weapon reentry vehicles fabricated in the United States. But, in most cases, these materials are produced in small quantities, and quality control is not consistent. Therefore, foreign fibers and production lines will continue to be sought after. [redacted]

31. Interest in metal matrix composite materials has been high, possibly for high-temperature applications such as jet engine turbine blades. Although several complex titanium and nickel-based alloys suitable for high-temperature applications have been developed in China, production problems still are prevalent. As a result, China's interest in acquiring casting and automated production lines remains high. [redacted]

32. For the most part, ceramics research in China probably lags the West by five to 10 years, particularly when it comes to production technologies. Much of the progress achieved over the last five years has involved Chinese scholars studying abroad and Chinese scientists during visits to foreign research facilities. Nevertheless, important new developments will be increasingly possible from scientists working at research facilities within China that are being upgraded. However, we

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may not become aware of advances in Chinese research for some time because of its underlying military nature. [redacted]

Biotechnology

33. In biotechnology, basic research tends to be more advanced than applied research. Advanced research has been noted in microbiology, protein synthesis, and genetic engineering to produce interferon and other advanced pharmaceuticals. Production technology, however, significantly lags research capabilities. Problems that result from the gap between research and production facilities are exemplified by the recent development by the Shanghai Institute of Biochemistry of a genetically engineered vaccine for a strain of hepatitis prevalent in East Asia. Even with this research breakthrough from China's premier biotechnology research institute, there is a lack of technology and marketing expertise needed to produce the vaccines in sufficiently high volume and quality for the marketplace. China, realizing that this gap exists, is taking measures to close it by entering into joint ventures with foreign firms. [redacted]

34. Agricultural applications of biotechnology are a high priority of the Chinese Government. The Chinese agricultural science community, composed of the CAS and the Chinese Academy of Agricultural Sciences, (CAAS) have a strong base in traditional agricultural research, which is exploited for biotechnology applications. The major factor preventing rapid progress is the gap between basic and applied research and the production and field support infrastructure to exploit the capability. CAAS attempted, with moderate success, to obtain foreign technology to correct their problems via joint ventures and targeted collaboration projects with foreign government and corporations. But agricultural production technology, such as planters, harvesters, and other machinery, remains primitive. Similarly, pesticides and other agricultural chemicals have tended to be neglected in Chinese research. [redacted]

35. [redacted]

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ANNEX C

China's International Science And Technology Agreements, 1978-86 (June)

Algeria

Jan 1982	S&T cooperation

Antigua and Barbuda

Jun 1984	Technology agreement

Argentina

Jun 1980	Economic, S&T cooperation
Aug 1983	Program on S&T cooperation 1983-84
Oct 1983	Scientific and technological cooperation
Apr 1985	Agreement on peaceful use of nuclear energy

Australia

Jun 1979	S&T cooperation
May 1980	S&T cooperation agreement
Oct 1981	Technical cooperation program
Apr 1982	Memorandum of understanding between State Science and Technology Commission (SSTC) and Academy of Technological Sciences of Australia
Apr 1983	Memorandum of geological S&T cooperation
Apr 1985	Agreement on scientific cooperation
Nov 1985	S&T cooperation—five years

Austria

Nov 1980	Long-term agreement on economic industrial and technical cooperation
Apr 1984	S&T cooperation

Bangladesh

Mar 1978	S&T cooperation
Mar 1979	S&T cooperation
Feb 1980	Protocol on economic and technical cooperation
Jun 1980	Protocol on S&T cooperation
Nov 1982	Protocol on S&T cooperation
Mar 1986	Economic and technical cooperation

Belgium

Jun 1979	Economic, industrial, S&T cooperation
Nov 1979	Economic, industrial, S&T cooperation
Dec 1980	S&T agreement

Botswana

Apr 1978	Economic and technical cooperation

Brazil

Mar 1982	S&T cooperation
Aug 1983	Technical cooperation
May 1984	Protocol on S&T cooperation
May 1984	Memorandum of understanding on cooperation in nuclear energy
Aug 1984	Cooperative use of nuclear energy
Oct 1984	Peaceful use of nuclear energy cooperation

Bulgaria

May 1978	Extension of scientific and technical cooperation agreement of 1955
Sep 1978	Protocol of 16th bilateral session on S&T cooperation
Nov 1979	Protocol of 17th bilateral session on S&T cooperation
Dec 1980	Protocol of 18th bilateral session on S&T cooperation
Sep 1981	Protocol of 19th bilateral session on S&T cooperation
Sep 1982	Protocol of 20th bilateral session on S&T cooperation
Sep 1983	Protocol of 21st bilateral session on S&T cooperation
Sep 1984	Economic and technical cooperation
Nov 1984	Protocol of 22nd bilateral session on S&T cooperation
Aug 1985	Protocol of 23rd bilateral session on S&T cooperation
Sep 1985	S&T, economic and trade cooperation

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Burkina

Nov 1984	Economic and technical cooperation

Burma

Jul 1979	Economic and technical cooperation
Jul 1980	Protocol on economic and technical cooperation
Jun 1984	Economic and technical cooperation

Burundi

Mar 1979	Economic and technical cooperation

Cape Verde

Jul 1980	Protocol on economic and technical cooperation

Central African Republic

Jul 1983	Economic and technical cooperation

Chad

Sep 1978	Protocol on economic and technical cooperation
Jul 1983	Protocol on economic and technical cooperation

Chile

Oct 1980	S&T cooperation

Colombia

Dec 1981	S&T cooperation

Congo

Aug 1979	Protocol on economic and technical cooperation
Jul 1980	Economic and technical cooperation
Nov 1982	Two protocols on economic and technical cooperation
Feb 1984	Economic, trade, and technical cooperation

Cuba

Aug 1984	Trade, cultural, and technical cooperation

Cyprus

Jun 1984	Economic and S&T cooperation

Czechoslovakia

Dec 1978	Protocol on S&T cooperation
Sep 1980	Protocol of 22nd session of bilateral committee on S&T cooperation
Sep 1981	Protocol of 23rd session of bilateral committee on S&T cooperation
Jul 1983	Protocol on economic and technological cooperation
Jul 1984	Economic and S&T cooperation
Oct 1984	Agreement on S&T projects
Dec 1985	Protocol on S&T cooperation
May 1986	S&T agreement

Denmark

Sep 1979	Economic and technical cooperation
Oct 1981	Educational, scientific, and cultural cooperation
Apr 1985	Protocol on S&T cooperation

Djibouti

Dec 1979	Economic and technical cooperation

Ecuador

May 1984	Economic and technical cooperation
May 1985	Protocol on economic cooperation

Egypt

Dec 1979	S&T cooperation
Apr 1983	Extension of S&T cooperation

Equatorial Guinea

Aug 1984	Economic and technical cooperation

Ethiopia

Apr 1984	Protocols on economic and technical cooperation

Finland

May 1979	Economic and S&T cooperation
Sep 1980	Protocol of first session of joint committee on economic and S&T cooperation

France

Jan 1978	S&T cooperation
Jun 1978	S&T cooperation between the Chinese Institute of Petrochemistry and the French Petrochemistry Institute

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Oct 1978	Supplemental protocol for S&T exchange, also scientific cooperation between Chinese Academy of Sciences (CAS) and the French State Center of Science and Research
Jan 1979	Three-year scientific cooperation on basic research between the CAS and the French Atomic Energy Commission
May 1979	S&T cooperation in metrology
Dec 1979	Geological and S&T cooperation
Dec 1979	Protocol on S&T cooperation
Jul 1981	Cooperation between Biological Department of CAS and the French National Institute of Health and Medical Research
Nov 1982	Civil application of nuclear cooperation
Jun 1983	Expansion of S&T cooperation 1983-84
Apr 1984	Signed minutes for S&T cooperation
Nov 1985	Minutes of S&T cooperation talks
May 1986	Nuclear safety agreement

Gabon

Dec 1983	Protocol on economic and technical cooperation

East Germany

Jun 1983	Posts and telecommunications cooperation
Dec 1983	Protocol on S&T for 1984-85
Apr 1985	Protocol on S&T cooperation
Apr 1985	Cooperation between SSTC and GDR Ministry of Technology
Nov 1985	Economic S&T cooperation
May 1986	Protocol on S&T cooperation

West Germany

Sep 1978	Scientific cooperation between CAS and the German Max Planck Society
Oct 1978	S&T cooperation
May 1979	Cooperation between bilateral standardization institutes
Jun 1979	Protocol on S&T cooperation between CAS and Fraunhofer Society
Jun 1979	Cooperation in geological S&T
Nov 1979	Protocol on scientific cooperation
Sep 1981	Three-year cooperation between the CAS and the German Max Planck Society
Nov 1981	S&T and agricultural cooperation
Mar 1984	Space, S&T cooperation
May 1984	Peaceful use of nuclear energy
May 1984	Scientific and cultural cooperation 1984-85
Jul 1984	Summary of fourth meeting on S&T cooperation
Sep 1984	Protocol on economic and scientific cooperation
Feb 1986	Nuclear cooperation agreement
May 1986	S&T cooperation

Greece

Nov 1979	S&T cooperation
Jun 1983	Economic and technical cooperation

Guinea

Aug 1984	Economic and technical cooperation

Hungary

Nov 1978	Protocol of 18th bilateral session on S&T cooperation
Sep 1980	Protocol of 19th bilateral session on S&T cooperation
Oct 1981	Protocol of 20th bilateral session on S&T cooperation
Dec 1982	Protocol of 21st bilateral session on S&T cooperation
Dec 1983	Protocol of 22nd bilateral session on S&T cooperation
Apr 1984	Cooperation between Association of Hungarian Technical and Natural Scientific Societies and Chinese Academy of Space Technology
Jun 1984	S&T cooperation; establishment of bilateral committee for economic and S&T cooperation
Aug 1984	Protocol of 23rd session of the bilateral commission for S&T cooperation
Oct 1984	Executive program on scientific, educational and cultural cooperation 1985-86
Nov 1984	Public health and medical science cooperation
Jan 1986	S&T cooperation

Iran

Sep 1983	Cultural, S&T cooperation
Mar 1985	Protocol of joint committee on economy, trade, and S&T

Iraq

May 1981	Economic and technical cooperation

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Jun 1983	Protocol of first session of bilateral trade exchange, technical, and economic cooperation
Apr 1986	Economic and technical cooperation

Italy

Oct 1978	S&T cooperation
May 1979	Scientific cooperation between the CAS and the Italian Research Committee
Oct 1979	Program of cultural and S&T cooperation 1980-81
May 1980	Protocol on S&T cooperation for peaceful uses of nuclear energy
Nov 1981	S&T and agricultural protocol for 1982
Nov 1983	Cooperation program on science and technology

Japan

Dec 1979	Bilateral cultural, educational, and scientific exchanges
May 1980	Expansion of bilateral S&T cooperation
Sep 1981	Nuclear cooperation and exchanges of experts and engineers, nuclear seminars and conferences
Mar 1984	S&T cooperation between Mitsubishi and China S&T Exchange Center
May 1984	Cooperation between Japanese Nuclear Fuel Development Corporation and the Uranium Geology Bureau of the Chinese Ministry of Nuclear Industry
Jul 1985	Nuclear cooperation agreement
Nov 1985	S&T cooperation

Kenya

Sep 1980	Economic and technical cooperation

Lesotho

May 1983	Economic and technical cooperation

Liberia

Jun 1978	Economic and technical cooperation

Libya

Oct 1982	Bilateral economic, trade, and S&T cooperation

Madagascar

Oct 1985	Agreement on economic and technological cooperation

Maldives

Aug 1981	Economic and technical cooperation
Oct 1984	Economic and technical cooperation

Mali

May 1979	Protocol on economic and technical cooperation
Dec 1984	Economic and technical cooperation

Mauritania

May 1980	Economic and technical cooperation

Mauritius

May 1983	Establishment of a bilateral joint commission for economic and technical cooperation

Mexico

Mar 1979	Protocol of the fourth bilateral session on S&T cooperation
Sep 1983	Summary of minutes on technology cooperation

Mozambique

May 1978	Economic and technical cooperation
Jul 1984	Economic and technical cooperation

Nepal

Jan 1982	Economic and technical cooperation

Netherlands

Oct 1980	Economic and technical cooperation

Nigeria

Mar 1981	Economic and S&T cooperation
Oct 1981	Protocols on economic and technical cooperation

North Korea

Jun 1978	Protocol of meeting on S&T cooperation
Jun 1978	Cooperation in hydrological work between Chinese Ministry of Water Conservancy and Electric Power and the Korean Meteorological and Hydrographical Bureau

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Oct 1978	Scientific cooperation between the Chinese and Korean Academies of Science for 1979-80
Oct 1979	Protocol of 19th bilateral session on S&T cooperation
Aug 1980	Protocol of 20th bilateral session on S&T cooperation
Dec 1980	Scientific cooperation between CAS and the Korean Academy of Sciences for 1981-82
Jun 1981	Protocol on teaching scientific research
Nov 1981	Protocol of 21st bilateral session on S&T cooperation
Oct 1982	Protocol of 22nd bilateral session on S&T cooperation
Jun 1983	Protocol of 23rd bilateral session on S&T cooperation
Jun 1984	Protocol of 24th bilateral session on S&T cooperation
Sep 1984	Plan on exchange and cooperation in seismological sciences and technology 1985-86
Dec 1984	Scientific cooperation 1985-86
Jun 1985	Protocol of 25th bilateral session on S&T cooperation

Norway

May 1979	Scientific cooperation for 1979-80
May 1980	Economic, industrial, and technical cooperation
Sep 1980	Economic, industrial, and technical cooperation
Oct 1980	Program on cultural, education, and scientific cooperation 1981-83
Jun 1985	Signed minutes of talks on technology

Pakistan

Jul 1978	Protocol on S&T cooperation
May 1980	Protocol on S&T cooperation 1980-81
Dec 1980	Protocol on economic and technical cooperation
Dec 1981	Protocol of 4th bilateral session on S&T cooperation
Oct 1982	Establishment of bilateral committee for economic and S&T cooperation
Feb 1986	Protocol on S&T cooperation

Papua New Guinea

Jun 1983	Technical cooperation

Philippines

Mar 1978	S&T cooperation
Oct 1978	Protocol on S&T cooperation
Jul 1979	Economic and technical cooperation
Dec 1980	Protocol of 3rd bilateral session on S&T cooperation
Nov 1981	Protocol of 4th bilateral session on S&T cooperation
Dec 1982	Protocol of 5th bilateral session on S&T cooperation
Jan 1984	Protocol of 6th bilateral session on S&T cooperation
Mar 1985	Protocol of 7th bilateral session on S&T cooperation

Poland

Oct 1979	Protocol on S&T cooperation
Dec 1980	Protocol on S&T cooperation 1981
Nov 1981	Protocol on S&T cooperation 1982
Dec 1982	Protocol of 15th bilateral session on S&T cooperation
Oct 1983	Protocol of 16th bilateral session on S&T cooperation
Jun 1984	Economic and technical cooperation
Sep 1984	Protocol of 17th bilateral session on S&T cooperation
Apr 1985	Summary of first meeting of Sino-Polish Commission for Economic, Trade, and S&T cooperation
Oct 1985	Protocol on S&T cooperation
Nov 1985	Protocol on trade exchanges, economic and technical cooperation
May 1986	Protocol on S&T cooperation

Portugal

Apr 1982	Cultural and S&T cooperation
Oct 1982	Economic and technical cooperation

Romania

May 1978	Economic and technical cooperation
Aug 1978	Establishment of a bilateral committee on economic and technical cooperation, also protocols involving S&T
Nov 1978	Protocol of 19th bilateral session on S&T cooperation
May 1979	Protocol of 1st bilateral meeting of economic and S&T cooperation
May 1980	Scientific cooperation between the CAS and the Romanian National Council for S&T 1980-82

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May 1980	Protocol of 2nd bilateral session on economic and S&T cooperation
May 1981	S&T cooperation
Nov 1981	Protocol of 3rd bilateral session on economic and S&T cooperation
Nov 1981	Protocol of 4th bilateral session on economic and S&T cooperation
Apr 1982	Expansion on economic and S&T cooperation
May 1983	Protocol of 5th bilateral session on S&T cooperation
Apr 1984	Scientific cooperation between the CAS and the Academy of Romania
Aug 1985	Protocol of 6th bilateral session on economic and S&T cooperation
May 1986	Protocol on S&T cooperation

Rawanda

Jun 1978	Economic and technical cooperation
May 1983	Cultural and scientific cooperation

Sao Tome and Principe

Jul 1983	Economic and technological cooperation

Seychelles

May 1978	Economic and technical cooperation
Apr 1983	S&T cooperation

Sierra Leone

Apr 1985	Economic and technical cooperation
Feb 1986	Economic and technical cooperation

Somalia

Apr 1978	Economic and technical cooperation
Mar 1986	Economic and S&T cooperation

Soviet Union

Dec 1983	Improvement of joint meteorological operations
Dec 1984	Economic and S&T cooperation
Jan 1985	Economic and S&T cooperation
Mar 1986	Economic and S&T cooperation

Spain

Apr 1981	Five-year cultural, educational, and scientific cooperation

Sri Lanka

Jan 1980	Economic and technical cooperation
May 1984	Establishment of a bilateral committee for economic and S&T cooperation
Aug 1984	Protocol on economic and technical cooperation
Mar 1986	Economic and technical cooperation

Sweden

Oct 1978	S&T cooperation between CAS and the Royal Swedish Academy of Engineering Sciences
Dec 1978	Ten year cooperation in industry, science and technology
Mar 1979	Scientific cooperation between the CAS and the Royal Swedish Academy
Oct 1981	Protocol on S&T cooperation
Oct 1984	Protocol of 5th session on joint industrial and S&T cooperation
Mar 1986	Protocol of 6th session on S&T cooperation

Tanzania

Sep 1978	Protocol on economic and technical cooperation
Mar 1980	Protocol on economic and technical cooperation
Aug 1983	Technical cooperation

Thailand

Mar 1978	S&T cooperation
Aug 1978	S&T cooperation
Nov 1978	Plan for S&T cooperation for 1978-79

Tunisia

Dec 1983	Establishment of bilateral commission for economic and technical cooperation
Oct 1984	Economic and technical cooperation

Turkey

Dec 1981	Economic, industrial, and technical cooperation
Mar 1986	Economic and technical cooperation

United Arab Emirates

Nov 1985	Agreement on economic trade and technical cooperation

United Kingdom

Nov 1978	Scientific cooperation between the CAS and the British Royal Society

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[redacted]

Nov 1978	S&T cooperation
Nov 1979	Railway and S&T cooperation
Dec 1981	Protocol for cooperation in S&T
Mar 1984	S&T cooperation between the CAS and the British Royal Society

United Nations

Jul 1980	Cooperation between the CAS and United Nations University
May 1983	Extension of scientific cooperation between CAS and United Nations University

United States

Oct 1978	Understanding on student exchanges
Nov 1978	Understanding on agricultural exchanges
Dec 1978	Agreement on space technology
Jan 1979	S&T agreement; implementing accord on high-energy physics
Apr 1979	Agreement for academic exchange to cooperate in science
May 1979	Protocol between SSTC and the US Department of Commerce for cooperation in S&T management; protocol on atmospheric S&T; protocol on metrology and standards
Jun 1979	S&T cooperation in medicine and public health between Department of Health, Education and Welfare, and Chinese Ministry of Public Health
Aug 1979	Protocol on hydroelectric power and related resources management
Jan 1980	Protocol on Earth sciences and on earthquake studies
Jan 1980	Science and technical cooperation
Feb 1980	Environmental protection S&T cooperation
Oct 1980	Cooperation between Chinese Nuclear Society and American Nuclear Society
Nov 1980	Protocol on S&T cooperation in medicine and public health
Dec 1980	Protocol on basic sciences
Dec 1980	Scientific cooperation between CAS and Smithsonian
Oct 1981	Protocol on nuclear safety matters; protocol on surface water hydrology
May 1983	Nuclear physics, biomedical transportation, aeronautical (four agreements)
Jun 1983	Exchange of technical experts and information
Jan 1984	Industrial and technical cooperation accord
Apr 1984	Cooperation agreement on nuclear energy
Apr 1984	Industrial S&T; S&T cooperation (two agreements)
May 1984	Work programs for cooperation in metallurgical, telecommunications, and electronics industries
May 1984	Scientific and nuclear cooperation
Jul 1984	Work program for industrial and technical cooperation in the aerospace industry
Sep 1984	Agreement with Georgia Tech for joint venture in research and technology
Oct 1984	Cooperative program for high-energy physics
Jan 1985	Agreement extending January 1980 Earth sciences agreements
May 1985	Extension of June 1979 medicine and public health agreement
Jul 1985	Protocol on S&T cooperation (four agreements)

Vanuatu

May 1983	Protocol on economic and technical cooperation

Venezuela

Nov 1981	S&T cooperation

Western Samoa

Jun 1980	Economic and technical cooperation

South Yemen

Apr 1978	Economic and technical cooperation

Yugoslavia

Aug 1978	Establishment of a bilateral commission on economic and S&T cooperation and a long-term agreement on S&T cooperation
Sep 1978	Scientific cooperation between CAS and the Yugoslav Commission of Academies and Sciences and Arts
Feb 1979	Protocol on S&T cooperation 1979
Mar 1979	S&T cooperation and protocol for 1st bilateral session of committee for economic and S&T cooperation

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Apr 1979	Cooperation in research of high voltage switches
Mar 1980	Protocol on 2nd bilateral session on economic and S&T cooperation
Apr 1980	Cooperation for peaceful use of atomic energy; exchange of S&T information
Oct 1981	Protocol on S&T cooperation 1981-82
Mar 1983	Protocol of 3rd bilateral session on economic and S&T cooperation
Sep 1984	Protocol of 4th bilateral session on economic and S&T cooperation

Zaire

Dec 1979	Technical cooperation
Nov 1985	Protocol on S&T cooperation 1985-86

Zambia

Jan 1979	S&T cooperation
Apr 1980	Economic and technical cooperation

Zimbabwe

Sep 1980	Economic and technical cooperation
Sep 1981	Protocol on economic and technical cooperation
Jan 1983	Economic and technical cooperation
Aug 1985	Agreement on economic and technical cooperation

Total: 327 agreements, 86 countries (not including the United Nations)

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